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IS 9101 (1979): Methods of sampling iron ore pellets [MTD
13: Ores and Raw Materials]



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IS : 9101 - 1979

Indian Standard
METHODS OF SAMPLING
IRON ORE PELLETS

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

September 1979

AMENDMENT NO. 1 SEPTEMBER 1987
TO
IS : 9101-1979 METHODS OF SAMPLING
IRON ORE PELLETS

[In order to clarify the procedure of taking unit samples from a moving conveyor belt by manual method and also to specify the dimensions of increment scoop, the Methods of Sampling Sectional Committee responsible for the preparation of this standard, decided to issue the following amendment.]

(*Page 3, clause 0.6*) — Substitute the following for the existing clause:

'0.6 For the determination of size distribution of iron ore pellets, sieves conforming to IS : 460 (Part 1)-1985* and IS : 460 (Part 2)-1985† shall be used. When such sieves are not available, other equivalent standard sieves as judged by the aperture may be used.'

(*Page 3, foot-note with '*' mark*) — Substitute the following for the existing foot-note:

***Specification for test sieves: Part 1 Wire cloth test sieves (*third revision*).**

†Specification for test sieves: Part 2 Perforated plate test sieves (*third revision*).

(*Page 4, clause 2.4*) — Substitute the following for the existing clause:

'2.4 The quantity of pellets collected by one or more operations of sampling device from the conveyor (unit sample is larger than the increment specified in Table 3).'

(*Page 4, clause 2.9, line 1*) — Delete the words '**for the Lot**'.

(*Page 5, clause 2.10*) — Substitute the following for the existing clause:

'2.10 The sample collected from a sub-lot or from the composite sample of a lot (see 2.9) for determining the physical characteristics of a lot or sub-lot.'

(*Page 5, Table 1, under col 'D', against '2.5 kg'*) — Substitute '**150**' for '**155**'.

(*Page 8, clause 4.2.5, Note*) — Substitute the following for the existing Note:

'NOTE — When a sampling scoop of 2.5 kg size is used for manual sampling in the above manner on a moving conveyor belt by thrusting the scoop in the pellet stream, a unit sample of 25 kg shall be drawn by taking successive increments across the stream. In such cases, the number of unit samples shall be adjusted in such a way as to get the minimum mass of gross sample.'

(Page 10, clause 4.4.2, third sentence) — Add the following at the end of the sentence:

‘by other means’.

(Page 11, clause 5.2.1, first sentence) — Delete the words within the bracket.

(Page 14, Table 6) — Substitute the following for the existing table:

TABLE 6 INCREMENT SCOOP DIMENSIONS, THICKNESS OF LAYERS AND SIZE OF INCREMENT

(Clause 5.3.1)

MAXIMUM PARTICLE SIZE mm	THICKNESS OF LAYER mm	INCREMENT SCOOP DIMENSIONS				SIZE OF INCREMENT (g)
		<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
10.0	30 to 40	60	35	60	50	250
5.0	25 to 35	50	30	50	40	150
3.5	20 to 30	40	25	40	30	75
2.0	15 to 25	35	20	35	30	50
1.0	10 to 20	30	15	30	25	25
0.25	5 to 10	15	10	15	12	5

NOTE — *a, b, c, d* are the dimensions of bottom length, height, width and top length of increment scoop respectively.

(Page 14, clause 6.2.1, third sentence, line 1) — Substitute the following for the existing line:

‘This crushed sample fraction along with the uncrushed fraction under 10 mm size shall be mixed and from’.

(Page 17, clause 7.3, line 8 and last line) — Substitute ‘Under 6.3 mm’ for ‘6.3 mm and below’.

(Page 17, clause 7.4, line 8) — Substitute ‘Under 6.3 mm’ for ‘6.3 mm and below’.

(Page 18, clause 8.1.1) — Substitute the following for the existing clause:

‘8.1.1 The method for determination of moisture content shall be in accordance with the procedure given in IS : 11690-1986 Methods of moisture determination of iron ore lot.’

(SMDC 4)

Indian Standard

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Indian Standard
**METHODS OF SAMPLING
IRON ORE PELLETS**

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 29 March 1979, after the draft finalized by the Methods of Sampling Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 The primary object of sampling of any material is to draw an inference about the quality of the lot on the basis of information derived from the sample. If the consignment is of uniform nature the inference so drawn is almost precise, which gives an accurate estimate of the quality, but when the material is heterogeneous in nature as is often the case with any raw material, the method by which a sample is obtained becomes critical in inferring about the quality of the consignment.

0.3 The efficiency of sampling largely depends on the degree of homogeneity of the consignment and the size of the sample. In case of heterogeneous consignment, obviously, the size of the sample should be more to arrive at an accurate estimate of the quality.

0.4 For obtaining reliable conclusions, it has been recommended that as far as possible iron ore pellets be sampled when in motion, that is, during loading or unloading or from conveyors.

0.5 In the formulation of this standard, due consideration has been given to international standards and practices prevailing in different countries. For this purpose, guidance has been obtained from the following standards.

ISO 3081 Iron ores — Increment sampling — Manual method

ISO 3083 Iron ores — Preparation of samples

JIS M 8710-1976 Methods of sampling, size determination, moisture determination and physical characteristics determination of iron ore pellets

0.6 For the determination of size distribution of iron ore pellets, sieves conforming to IS:460-1962* shall be used. When such sieves are not available, other equivalent standard sieves as judged by the aperture may be used. For corresponding sizes of BS and ASTM sieves, reference may be made to IS: 460-1962*.

*Specification for test sieves (*revised*).

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0.7 In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard prescribes the methods for sampling of iron ore pellets from conveyors, wagons/trucks/barges, ships, stock piles and also during production, for the determination of size distribution, moisture content, chemical composition and other physical properties in the lot.

2. TERMINOLOGY

2.0 For the purpose of this standard the following definitions shall apply.

2.1 Lot — The quantity of pellets offered for inspection at one time. A lot may consist of the whole or a part of the quantity ordered for.

2.2 Sub-lot — The quantity of pellets in each of the parts into which a lot is divided for the purpose of sampling.

2.3 Increment — The quantity of pellets obtained by a sampling device at one time from a lot or sub-lot; also a quantity taken in the increment reduction method.

2.4 Unit Sample — The quantity of pellets collected at one time from the conveyor (unit sample is larger than the increment specified in Table 3).

2.5 Gross Sample — The total quantity of pellets consisting of all increments or unit samples taken from a sub-lot.

2.6 Size Sample — The sample taken for the determination of the size distribution of the lot or sub-lot.

2.7 Moisture Sample — The sample taken for the determination of moisture content of the lot or sub-lot.

2.8 Laboratory Sample — The quantity of pellets obtained by reducing a gross sample following a specified procedure for determining the chemical composition of a lot or sub-lot.

2.9 Composite Sample (for the Lot) — The quantity obtained by mixing together proportional quantities of pellets representing the mass of each sub-lot into which a lot has been divided. It may be a composite of laboratory samples, or a composite of divided uncrushed parts of samples from each sub-lot for the determination of physical properties of a lot.

*Rules for rounding off numerical values (*revised*).

2.10 Physical Test Sample — The sample collected from a lot or a sub-lot or from the composite sample (for the lot) (*see* 2.9) for determining the physical characteristics of a lot or sub-lot, such as tumbler test sample, crushing (strength) test sample and reducibility (chemical) test sample.

3. GENERAL RULES

3.1 The methods of collecting increments or unit samples from a lot may be classified into following types or a combination of any of them:

- a) Sampling from conveyors,
- b) Sampling from wagons or trucks or barges,
- c) Shipment sampling,
- d) Stockpile sampling, and
- e) Sampling during production.

3.2 Sampling shall preferably be carried out during loading or unloading (shifting) of the lot. It shall be carried out by the method of periodic systematic sampling with a random start.

3.3 Increments shall be drawn, as far as possible, by a single motion of the sampling device.

3.4 The dimensions of the sampling scoop for drawing increments (in manual sampling) shall be as given in Table 1 (*see* Fig 1).

TABLE 1 DIMENSIONS OF SAMPLING SCOOP

CAPACITY OF SCOOP	DIMENSIONS, mm						
	A	B	C	D	E	F	G
4 kg	175	120	100	150	65	350	30
2.5 kg	175	120	65	155	65	350	30

3.5 In the case of mechanical sampling, the sampling device should take the largest particle in a lot easily.

3.6 The interval of drawing the increment shall be, as far as possible, uniform in terms of mass throughout the whole quantity of the lot. However, if the rate of the handling quantity is uniform, the interval of drawing the increments may be based on time unit in place of quantity unit.

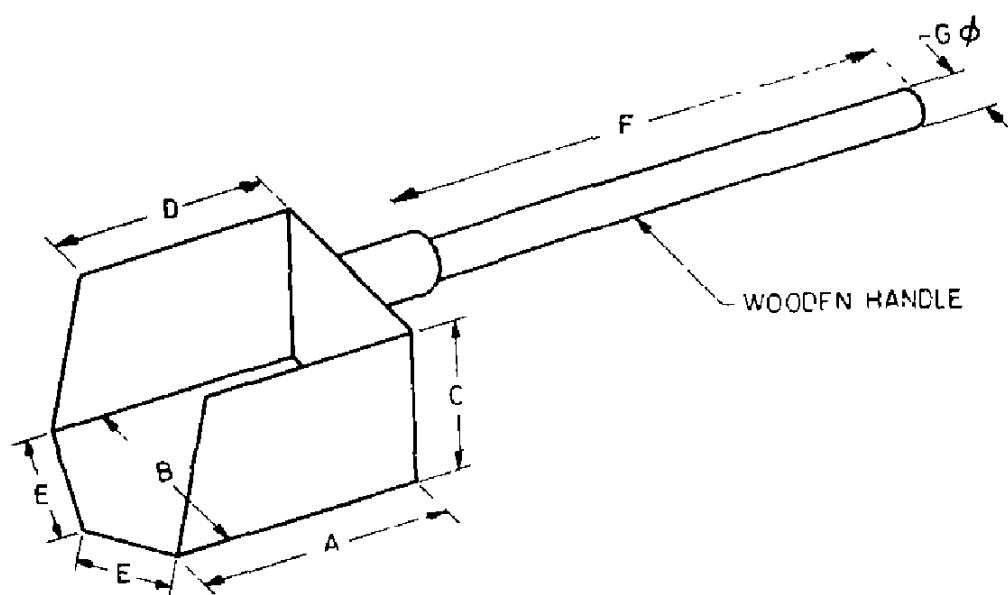


FIG. 1 SAMPLING SCOOP

3.7 Before collecting the increments or the unit samples, the speed of the conveyor and the quantity of material passing a certain point in a given time shall be ascertained so that an appropriate spacing of the increments or unit samples may be arranged over whole of the lot.

3.8 The increments or unit samples shall be of approximately equal mass. For the preparation of gross samples these increments or unit samples may be combined by taking and mixing individual increments or unit samples at a proper stage of sample preparation.

3.9 Throughout sampling as also during sample preparation and testing, care shall be taken to avoid contamination of the sample with any foreign material.

3.10 In the case of pellets, possibilities of segregation of particle size fractions are often encountered. Hence the sampling points and the methods of collecting increments or unit samples have to be carefully planned to avoid bias.

4. METHODS OF SAMPLING

4.1 General — For the purpose of sampling, a lot shall be divided into a number of sub-lots of approximately equal mass as specified in Table 2. When it is not practicable to have sub-lots of approximately equal mass, sub-lots with varying mass may also be permitted.

**TABLE 2 MINIMUM NUMBER OF SUB-LOTS INTO WHICH
A LOT IS DIVIDED**

(*Clauses 4.1, 4.2.2, 4.3.1.1, 4.4.1 and 4.5.1*)

MASS OF THE LOT (tonnes)	NUMBER OF SUB-LOTS
Up to 1 000	1
1 001 to 2 000	2
2 001 to 5 000	3
5 001 to 15 000	4
15 001 to 30 000	5
30 001 to 45 000	8
45 001 to 70 000	10
70 001 and above	15

4.1.1 A representative gross sample shall be drawn from each of the sub-lots and shall be kept separately. Thus there will be as many gross samples as the number of sub-lots into which the lot has been divided.

4.1.2 The number of increments to be taken from a sub-lot for the gross sample shall be governed by the mass of the gross sample and the mass of the increments as specified in Table 3.

**TABLE 3 MINIMUM MASS OF THE GROSS SAMPLE AND
MINIMUM NUMBER OF INCREMENTS**

(*Clauses 2.4, 4.3.2.2, 4.3.3.1, 4.3.4.3, 4.4.2, 4.5.2.1 and 4.6.1*)

Mass of gross sample, <i>M_{in}</i>	300 kg
Mass of the increment, <i>Approx</i>	4 kg
Number of increments, <i>M_{in}</i>	75

4.1.3 The number of increments shall be evenly distributed over the sub-lot as detailed in 3.6. The increments shall be drawn with the help of a suitable sampling scoop (*see* Fig. 1) at regular intervals.

4.2 Sampling from Conveyors

4.2.1 When a lot is being conveyed by means of a belt conveyor the increments shall be taken from a specified place on conveyor or at a specified transfer point of conveyor. The sampling point should be as close as possible to the discharge point to avoid the physical effects of handling.

4.2.2 The periodic systematic sampling should be carried out with random start. The lot shall be divided into a number of sub-lots of approximately equal mass as specified in Table 2. This can be done by dividing the size

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of the lot (in tonnes) by the number of sub-lots, which will give the size of the sub-lot. This size divided by the number of increments gives the interval of taking the increments. The increment shall be drawn with the help of a suitable sampling scoop or a sampling device or by stopping the conveyor belt at regular intervals.

4.2.3 The increments shall be taken from the moving conveyor belt at a fixed place by cutting the whole cross-section and thickness of the pellet stream with the mechanical sampling device in one operation. The receptacle shall be wide and big enough to take all sizes and not to allow overflowing.

4.2.4 If it is practicable to stop the belt periodically, unit samples may be drawn at a fixed location of the belt conveyor. The mass of each unit sample so drawn shall not be less than 25 kg and it shall be collected from the full width and thickness of the pellets. The minimum number of unit samples to be drawn, at regular intervals, to constitute a gross sample shall be 12.

4.2.5 If it is not possible to draw samples from the moving belt by the two methods indicated above, increments may be manually drawn with the help of a suitable scoop, successively from the right, the centre and from the left sides of the pellet stream of the belt along the same width of a moving conveyor. To ensure that every portion of the pellets is contained in the sample, the scoop should sweep the bottom of the conveyor. However, since the pellets tend to segregate during transportation on conveyor belts, care should be taken to see that bias in sampling is not introduced, in the process

NOTE — When a sampling scoop of 2.5 kg size is used for manual sampling on a moving conveyor belt by thrusting the scoop in the pellet stream, successively a unit sample of 25 kg shall be drawn.

4.2.6 The material collected from various increments or unit samples in a sub-lot shall be combined and mixed together to constitute a gross sample.

4.3 Sampling from Wagons or Trucks or Barges

4.3.1 General

4.3.1.1 For the purpose of sampling, the lot representing the total number of wagons or trucks or barges shall be divided into a suitable number of sub-lots (if possible of approximately equal mass) in accordance with the requirements laid down in Table 2.

4.3.1.2 In order to get a representative gross sample, the pellets shall be sampled from the point selected at random in the new surface exposed during loading or unloading of wagons or trucks or barges. Samples shall not be collected as far as possible from loaded wagons, trucks or barges.

4.3.2 Sampling from Wagons

4.3.2.1 When pellets are loaded into or unloaded from the wagons, it is recommended that the sample is drawn by mechanical means, during loading or unloading.

4.3.2.2 A minimum of two increments per wagon shall be drawn up to a lot of 4 000 tonnes which is the normal size of the lot. The mass of the increments and the gross sample shall be in accordance with Table 3. The increment shall be taken from the place where the pellets have been just removed by the handling equipment. If the handling equipment is a grab-bucket increments may be taken inside the grab-bucket in such a way that no bias is introduced in the sample.

4.3.3 Sampling from the Trucks

4.3.3.1 Since the capacity of the trucks is small (approximately 8-15 tonnes), it will be necessary to select the trucks for sampling. For this purpose, a minimum of ten percent of the trucks subject to a minimum of ten and maximum of hundred trucks shall be selected at random from the sub-lot. From each of the trucks so chosen, an approximately equal number of increments shall be drawn from each truck so as to get the required number of increments, as given in Table 3.

4.3.3.2 The mass of the increments and size of gross sample shall be as in Table 3.

4.3.4 Sampling from Barges

4.3.4.1 The pellets shall be sampled during loading or unloading of the barges. If the loading or unloading is by means of conveyors, as is generally the case, the procedure for sampling from conveyors (*clause 4.2*) shall be followed.

4.3.4.2 If the pellets are unloaded or loaded into the barges with the help of grab-buckets, the sample shall be drawn from the place from where the pellets have been just removed by the grab-bucket. Sampling shall be done carefully so as to avoid any bias during the process specially with respect to size distribution.

4.3.4.3 The mass of the increments and size of gross sample shall be as in Table 3.

4.4 Sampling from Ships

4.4.1 For the purpose of sampling, the quantity of the pellets to be loaded into or unloaded from a ship shall be divided into a suitable number of sub-lots of approximately equal mass in accordance with Table 2.

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4.4.1.1 A representative gross sample shall be drawn from each of the sub-lots and shall be kept separately. Thus there will be as many gross samples as the number of sub-lots into which a lot has been divided.

4.4.2 In order to get a representative gross sample, the pellets shall be sampled as far as possible when in motion. If it is taken on a conveyor, the gross sample shall be collected according to the procedure laid down in 4.2. If not, the gross samples may be drawn during loading or unloading of the ship. For this purpose the number of increments to be taken at regular intervals and the mass of the increments and the gross sample shall be in accordance with Table 3.

4.4.3 The sample collected from the various increments or unit samples from a sub-lot shall be combined and mixed into a gross sample.

4.5 Sampling from Stockpiles

4.5.1 For the purpose of sampling, the quantity of pellets in a stockpile shall be divided into a suitable number of sub-lots of approximately equal mass as specified in Table 2.

4.5.1.1 A representative gross sample shall be drawn from each of the sub-lots and shall be kept separately. Thus there will be as many gross samples as the number of sub-lots into which the lot has been divided.

4.5.2 Sampling of pellets from stockpiles shall be carried out, as far as possible, when they are in motion, that is, during the formation of the stockpiles or during the shifting of the stockpiles to other places. Sampling from stationary stockpile shall not be conducted as this would introduce significant bias in sampling.

4.5.2.1 The number of increments to be taken from a sub-lot for making up the gross sample, shall be governed by the mass of the gross sample and the mass of the increments as specified in Table 3. This number shall be equally distributed over the sub-lot. The increment shall be drawn with the help of a suitable sampling scoop (*see Fig. 1*) at regular intervals during the formation or shifting of the stockpiles.

4.6 Sampling During Production

4.6.1 The quantity of pellets produced daily by a pelletizing plant may be considered as a lot for the purpose of sampling and shall be divided into sub-lots of approximately equal mass, one per shift. The number of increments to be taken from a sub-lot for making up the gross sample shall be governed by the mass of the gross sample and the mass of the increments as specified in Table 3. This number shall be evenly distributed over the sub-lots. The increments shall be drawn mechanically or manually at the final discharge end from the plant, from where the finished pellets are discharged.

4.6.2 If the discharge end is a chute, the whole cross-section of the falling stream shall be cut with a suitable sampling device in one or several motions to obtain a unit sample of at least 25 kg.

5. SAMPLE PREPARATION

5.0 In the case of iron ore pellets a number of tests for the determination of physical properties of uncrushed sample are required. This necessitates that gross samples (in part or full) are required to be divided further to collect the requisite quantity of sample for physical tests, before crushing. In this case, the determination of size distribution shall be carried out on the divided sample.

A general scheme of sample division and sample preparation is given in Appendix A.

5.1 Methods of Sample Preparation

5.1.1 Sample Division—One or more of the following methods of sample division shall be used, for dividing a gross sample (in part or full), or a composite sample :

- a) Method using riffle divider,
- b) Increment reduction method, and
- c) Coning and quartering method.

5.1.2 Of these three methods, the first shall be used in dividing the uncrushed pellet samples. All the three methods shall be used after crushing the pellets under 10 mm size.

5.2 Method Using Riffle Divider

5.2.1 The sample of pellets is mixed, placed with uniform thickness into a riffler tray (closed on three sides and open on one side, the width of which is exactly equal to the sum of widths of all the slots of the riffle) and divided in two parts by tilting the tray slowly into the middle of the riffles (at right angle to the riffle). Either of the divided parts shall be selected randomly as the divided sample.

5.2.2 The relation between maximum particle size and minimum mass of sample retained after division shall be in accordance with Table 5.

NOTE 1 — Any material, if retained in the slots of the riffle, should be properly removed and added to the divided sample.

NOTE 2 — Emptying of the riffler tray during sample division shall be carried out in such a manner as to prevent any bias in the division.

NOTE 3 — The angle between inclined surfaces of adjacent chutes shall be 60°.

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NOTE 4 — The number of chutes shall be as indicated in Table 4.

NOTE 5 — The sample receivers shall be such as to ensure the prevention of scattering and rising of fine particles.

**TABLE 4 PARTICLE SIZE OF SAMPLE AND WIDTH OF CHUTE
OF RIFFLE DIVIDER**

(Clause 5.2.2)

PARTICLE SIZE, mm	WIDTH OF CHUTE, mm	NUMBER OF CHUTES, <i>Min</i>
Over 10 and up to 30	60	12
Over 4.75 and up to 10	20	16
Over 1.70 and up to 4.75	10	16
1.70 and under	6	16

TABLE 5 PARTICLE SIZE AND SAMPLE RETAINED AFTER DIVISION

(Clause 5.2.2)

PARTICLE SIZE OF SAMPLE, mm UP TO AND INCLUDING	MINIMUM MASS OF SAMPLE RETAINED AFTER DIVISION, kg
30	140
10	20
4.75	10
1.70	2.5
0.85	0.5

5.3 Increment Reduction Method

5.3.1 The pellets crushed under 10 mm size shall be mixed and spread, on a smooth non-moisture absorbing plate, into a uniform flat rectangle with thickness, depending upon the particle size, as specified in Table 6. The rectangle so formed shall be divided into 5 equal parts lengthwise and four equal parts breadthwise. From each of the 20 parts so obtained (see Fig 2) equal quantity of material, not less than that specified in Table 6, shall be collected (using an increment scoop of suitable dimensions). A supporting plate shall be used for proper collection of the sample. While taking increments the scoop (see Fig 3) shall be inserted to the bottom of the layer. All the 20 increments so collected shall be combined together to form a reduced sample.

5.4 Coning and Quartering Method

5.4.1 The crushed pellets (10 mm and under) shall be mixed and then scooped into a cone-shaped pile, by depositing each scoopful on top of the

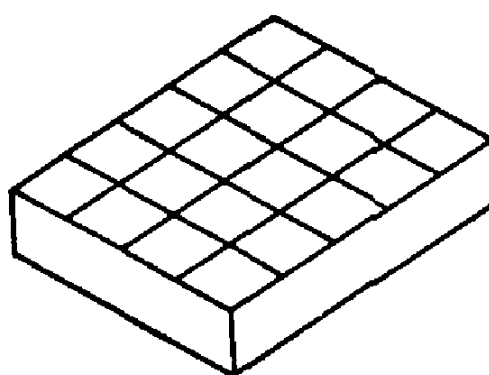
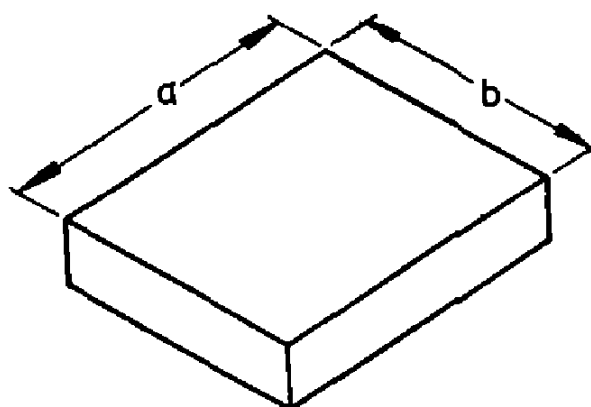


FIG. 2 ONE INCREMENT FROM EACH PART

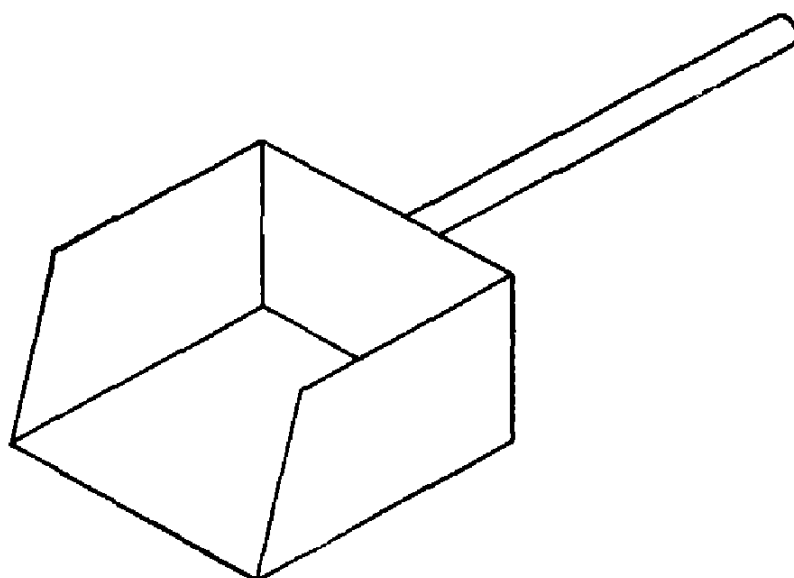


FIG. 3 INCREMENT SCOOP FOR INCREMENT REDUCTION METHOD

**TABLE 6 PARTICLE SIZE, THICKNESS OF THE LAYERS
AND SIZE OF INCREMENT**

(Clause 5.3.1)

PARTICLE SIZE,	THICKNESS OF LAYER,	SIZE OF INCREMENT,
mm	mm	g
10	30 to 40	250
4.75	25 to 35	150
3.35	20 to 30	75
1.70	15 to 25	40
0.85	10 to 20	25
0.15	5 to 10	5

preceding one. Care must be taken to drop each scoopful on the apex of the cone, so as to ensure even distribution of coarse and fine particles on all sides of the cones and that the centre of the cone is not displaced. After the cone is formed, it shall be flattened by pressing the top of the cone with the smooth surface of the scoop so as to form a flattened circular heap of uniform thickness and its centre shall coincide with the centre of the original cone. This flattened heap shall then be cut into quarters by two lines which intersect at right angles the centre of the heap. Two diagonally opposite sectors shall be completely removed and rejected. The remaining part shall be accepted as the reduced sample. This process may be repeated till the required amount of sample is obtained.

6. PREPARATION OF SAMPLES FOR VARIOUS PHYSICAL TESTS

6.0 A diagrammatic representation of sample preparation is given in brief in Appendix A.

6.1 Preparation of Final Sample for Determination of Size Distribution — As far as possible, the whole of the gross sample shall be used for determination of size distribution. In case this cannot be done, the final sample for determination of size distribution may be prepared by reducing the gross sample (preferably by riffle division method) (see Appendix A). The balance part shall be preserved as moisture and laboratory sample. All samples above 4.75 mm after determination of size distribution shall be used for physical tests in 6.3.

6.2 Preparation of Final Sample for Determination of Moisture and Chemical Analysis

6.2.1 Each of the divided gross samples meant for moisture determination and chemical analysis in 6.1 shall be crushed separately (see Appendix A).

Pellets of sizes greater than 10 mm shall be first crushed in a jaw crusher, roller crusher, or manually using hammer and manganese steel flat plate till the pellets are of size under 10 mm. This sample shall be mixed and from this (a) a sample of approximately 2 kg shall be collected (preferably by riffle division method combined with increment reduction method) as moisture sample, and (b) a sample of approximately 20 kg shall be obtained (preferably by riffle division method) as laboratory sample, which shall then be further processed in successive stages of crushing, mixing and dividing (see Appendix A) so as to obtain a final laboratory sample of size 150 microns or less for determination of chemical analysis.

6.2.2 From 2 kg of moisture sample, prepare two duplicate samples by increment reduction method of at least 500 grams each as the final duplicate moisture samples. The rest of the sample, if desired, shall be preserved for a short time in air-tight containers.

6.3 Preparation of Samples for Various Physical Tests

6.3.1 The physical test sample obtained from each gross sample (or part of gross sample) shall be sieved on a sieve having 4.75 mm square aperture. The fraction of size above 4.75 mm shall be further divided without crushing so as to obtain a sample of approximately 150 kg which shall be further reduced to obtain various samples as given in 6.3.2 to 6.3.6, if tests on individual gross samples are required to be carried out. If tests are required to be carried out on the composite sample, all physical test samples representing each sub-lot may be combined at this stage to obtain a composite sample for physical test by mixing them in proportion to the mass corresponding to each sub-lot into which the lot is divided. This sample shall be further divided so as to obtain about 250 kg sample for various physical tests in 6.3.2 to 6.3.6. The outline of the procedure is given in Appendix A.

6.3.2 Preparation of Final Tumbler Test Sample

6.3.2.1 From the physical test sample obtained in 6.3.1 one tumbler test sample of about 100 kg shall be prepared. The rest of the sample shall be preserved for other physical tests.

6.3.2.2 The tumbler test sample shall be dried at $105 \pm 5^\circ\text{C}$ till free from moisture and cooled to the room temperature and then divided (preferably by riffle division method) so as to obtain 2 tumbler test samples of about 25 kg each for each sub-lot or 4 final tumbler test samples of about 25 kg each for the whole lot. The tumbler test shall be carried out in accordance with IS : 6495-1972*.

6.3.3 Preparation of Final Crushing Test Sample — From the reserved sample for other physical tests obtained after preparing tumbler test sample as in 6.3.2, a crushing test sample of about 5 kg shall be prepared

*Method of tumbler test for pellets, sinters and sized iron ores.

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according to the method specified in 5 without crushing. The crushing test shall be carried out in accordance with IS : 8625-1977*.

6.3.4 Preparation of Final Reducibility Test Sample

6.3.4.1 From the remaining sample, after the preparation of crushing test sample as in 6.3.3, a reducibility test sample of about 5 kg shall be prepared by sample reduction method. The reducibility test sample shall be mixed well and three samples of 500 grams each obtained (two for the reducibility test and one for chemical analysis before test) without crushing the samples. The balance sample shall be preserved for 6.3.5.

6.3.4.2 The final sample for compression strength after reduction shall be prepared from the sample after its reducibility has been determined. The compression strength of pellets after reduction shall be determined in accordance with IS : 8604-1977†.

6.3.5 Preparation of Final Swelling Test Sample — Twelve pellets of specific size shall be selected at random from the sample left over after the preparation of reducibility test sample as in 6.3.4.1 as the final swelling test sample. The swelling index of the pellets shall be determined in accordance with IS : 8624-1977‡.

6.3.6 Preparation of Other Test Samples — The reserved sample kept aside during preparation of the physical test sample, shall be used for the preparation of other physical test samples.

7. METHOD OF DETERMINING PARTICLE SIZE DISTRIBUTION

7.1 The size distribution of the pellets in a lot shall normally be estimated as recommended below (see Appendix A):

- a) Over 20 mm,
- b) Over 16 mm and up to 20 mm,
- c) Over 12.5 mm and up to 16 mm,
- d) Over 10 mm and up to 12.5 mm,
- e) Over 6.3 mm and up to 10 mm, and
- f) 6.3 mm and below.

NOTE — In the determination of particle size distribution IS sieves of suitable size specified in IS : 460-1962§ shall be used.

*Method for determination of crushing strength of iron ore pellets.

†Method for determination of compression strength of iron ore pellets after reduction.

‡Method for determination of swelling index of iron ore pellets.

§Specification for test sieves (revised).

7.2 Each sample shall be sieved through selected IS sieves and pellets retained in each of the sieves and those passing through the smallest sieves shall be weighed separately.

7.3 Size distribution of pellets in a lot shall be estimated as follows (when sub-lots are of equal mass):

$$\begin{aligned}
 \text{Over 20 mm, percent} &= \frac{a_1 + a_2 + \dots}{w_1 + w_2 + \dots} \times 100 \\
 \text{Over 16 mm, percent} &= \frac{b_1 + b_2 + \dots}{w_1 + w_2 + \dots} \times 100 \\
 \text{Over 12.5 mm, percent} &= \frac{c_1 + c_2 + \dots}{w_1 + w_2 + \dots} \times 100 \\
 \text{Over 10 mm, percent} &= \frac{d_1 + d_2 + \dots}{w_1 + w_2 + \dots} \times 100 \\
 \text{Over 6.3 mm, percent} &= \frac{e_1 + e_2 + \dots}{w_1 + w_2 + \dots} \times 100 \\
 \text{6.3 mm and below, percent} &= \frac{f_1 + f_2 + \dots}{w_1 + w_2 + \dots} \times 100
 \end{aligned}$$

where

w_1, w_2 are the masses of different gross samples (kg) or parts thereof

$a_1, a_2 \dots$ are the corresponding masses of pellets over 20 mm in size (kg)

$b_1, b_2 \dots$ are the corresponding masses of pellets over 16 mm in size (kg)

$c_1, c_2 \dots$ are the corresponding masses of pellets over 12.5 mm in size (kg)

$d_1, d_2 \dots$ are the corresponding masses of pellets over 10 mm in size (kg)

$e_1, e_2 \dots$ are the corresponding masses of pellets over 6.3 mm in size (kg)

$f_1, f_2 \dots$ are the corresponding masses of pellets of size 6.3 mm and below (kg)

7.4 If sub-lots vary in mass, weighted means of each of the size fractions corresponding to the mass of sub-lots shall be calculated as follows:

$$\begin{aligned}
 \text{Over 20 mm, percent} &= \frac{a_1 T_1 + a_2 T_2 + \dots}{w_1 T_1 + w_2 T_2 + \dots} \times 100 \\
 \text{Over 16 mm, percent} &= \frac{b_1 T_1 + b_2 T_2 + \dots}{w_1 T_1 + w_2 T_2 + \dots} \times 100
 \end{aligned}$$

$$\begin{aligned}
\text{Over 12.5 mm, percent} &= \frac{c_1 T_1 + c_2 T_2 + \dots}{w_1 T_1 + w_2 T_2 + \dots} \times 100 \\
\text{Over 10 mm, percent} &= \frac{d_1 T_1 + d_2 T_2 + \dots}{w_1 T_1 + w_2 T_2 + \dots} \times 100 \\
\text{Over 6.3 mm, percent} &= \frac{e_1 T_1 + e_2 T_2 + \dots}{w_1 T_1 + w_2 T_2 + \dots} \times 100 \\
\text{6.3 mm and below, percent} &= \frac{f_1 T_1 + f_2 T_2 + \dots}{w_1 T_1 + w_2 T_2 + \dots} \times 100
\end{aligned}$$

where

$a_1, a_2 \dots b_1, b_2 \dots c_1, c_2 \dots d_1, d_2 \dots e_1, e_2 \dots f_1, f_2 \dots w_1, w_2 \dots$
are as specified in 7.3.

$T_1, T_2, \dots$ are corresponding mass (in tonnes) of each sub-lot.

7.5 The percentage of each particle size fraction of a consignment shall be expressed to the first decimal place.

8. NUMBER OF TESTS

8.1 Moisture Samples — All the moisture samples representing a lot shall be tested individually for moisture content. To avoid the change in the moisture content, the moisture determination shall be done as quickly as possible, after the sample is taken.

8.1.1 The method for determination of moisture shall be in accordance with the procedure given in the draft 'Indian Standard methods for determination of moisture for iron ore pellets' (*under preparation*).

8.2 Laboratory Samples — All the laboratory samples shall be tested individually for important characteristics. For the remaining, a composite sample prepared by mixing proportionate quantities of the laboratory samples shall be analyzed. Unless otherwise agreed, the samples shall be analyzed as below for various characteristics:

*Characteristics for which
Laboratory Samples are
Analyzed Individually*

- a) Silica (SiO_2)
- b) Alumina (Al_2O_3)
- c) Iron (Fe)

*Characteristics for which
a Composite Sample is
Analyzed*

- a) Ferrous oxide
- b) Phosphorus
- c) Sulphur
- d) Calcium oxide (CaO)
- e) Magnesium oxide (MgO)
- f) Titanium
- g) Loss on ignition
- h) Manganese

9. REPORTING

9.1 Reporting of Chemical Composition

9.1.1 For those characteristics, where a composite sample has been tested, only one test result will be available and that result shall be reported as the value of the characteristic for the lot sampled.

9.1.2 For those characteristics, where only one individual sample is taken and tested, only one result will be available and that result shall be reported as the value of the characteristics for the lot sampled.

9.1.3 When only two laboratory samples have been analyzed individually from a lot, the average of the two available test results shall be reported as the value of the characteristic for the lot sampled. In the case of sub-lots of approximately equal mass, this average shall be calculated as one-half of the sum of the two test results. If the sub-lots are of varying mass, the weighted average shall be calculated as the sum of each test result multiplied by corresponding fraction obtained on dividing the sub-lot mass by the total mass. The individual results shall also be reported to give an indication of the range of variation in quality.

9.1.4 When three or more laboratory samples have been analyzed individually from a lot for any characteristic, the following procedure shall be followed to assess the average quality and its limits of variation:

Let $x_1, x_2, x_3, \dots, x_n$ be the results of analyzing n laboratory samples for a particular characteristic.

Calculate,

Average ($\bar{x}$) = $\frac{(x_1 + x_2 + \dots + x_n)}{n}$ if sub-lots are of approximately equal mass

or Weighted Average ($\bar{x}$) = $\frac{(w_1 x_1 + w_2 x_2 + \dots + w_n x_n)}{w_1 + w_2 + \dots + w_n}$
if $w_1, w_2, \dots, w_n$ are the mass of the n sub-lots

Range (R) = the difference between the maximum and the minimum values (when n is less than 10)

or Mean Range ($\bar{R}$) = The average value of ranges. When the number of sub-lots (n) is equal to 10 or 15, the corresponding results on laboratory samples (10 or 15) should be constituted into groups of 5 in the order of their occurrence. For each group, range (R) should be calculated and the average value ($\bar{R}$) of the R 's should be used in the subsequent clause.

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The average level of that characteristic in the lot shall be reported as equal to $(\bar{x})$.

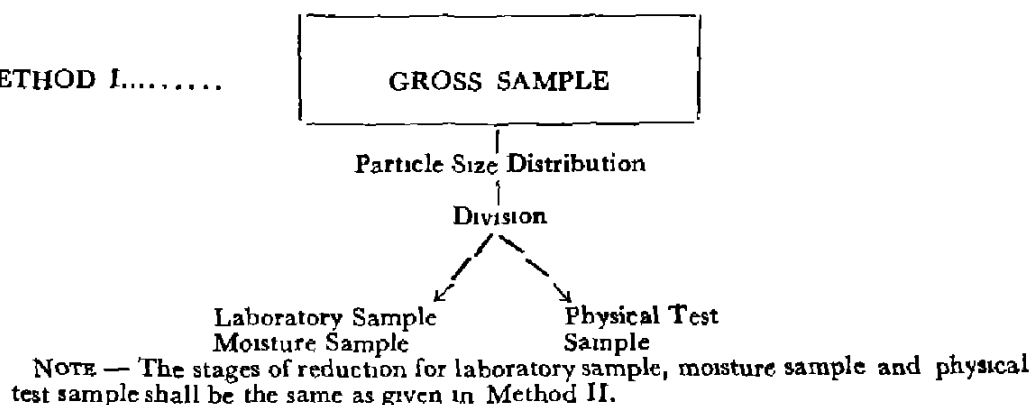
The limits of variation in the average level of the lot shall be reported as $(\bar{x} \pm hR)$ or $(\bar{x} \pm h\bar{R})$, where h is a factor, the value of which depends on the number of samples analyzed. The appropriate value of the factor h shall be taken from the following table:

<i>Number of Laboratory Samples Analyzed</i>	<i>Value of the Factor, h</i>
3	1.30
4	0.72
5	0.51
8	0.29
10	0.31
15	0.24

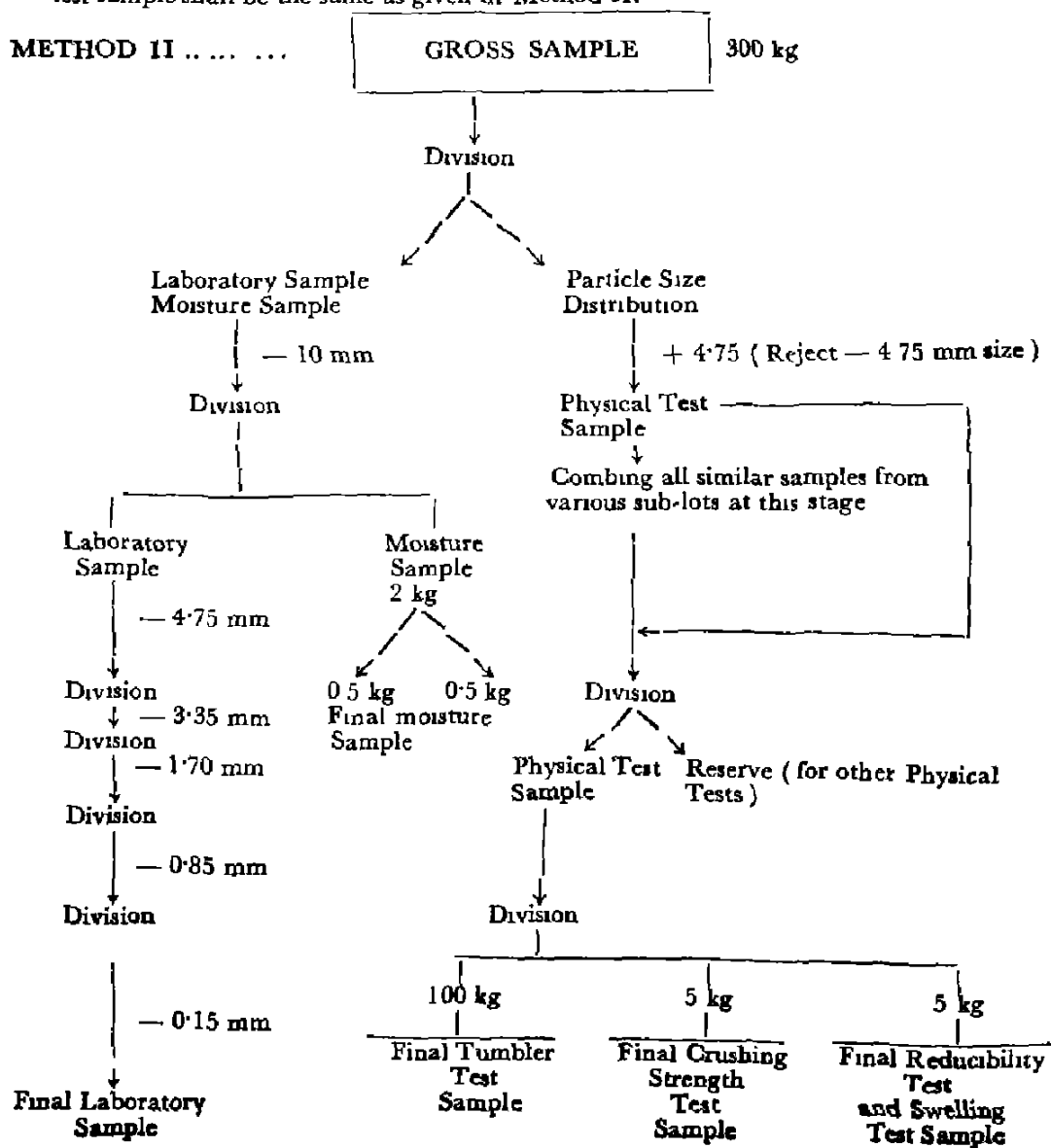
9.2 Reporting of Moisture Content — The results obtained by testing all the moisture samples representing a lot individually shall be reported in accordance with 9.1.2, 9.1.3 and 9.1.4.

APPENDIX A **(Clauses 6.0, 6.1, 6.2.1, 6.3.1 and 7.1)** **SAMPLING PROCEDURE**

METHOD I.....



METHOD II



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(Continued from page 2)

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